FALL PROTECTION FOR STRUCTURAL STEEL ERECTION

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Introduction

Fall protection is a concept that describes behaviors, systems, processes, procedures, equipment, and rules intended to protect workers from fall hazards. Fall protection does not mean bulky or cumbersome equipment. It doesn't interfere with work tasks, and it doesn't get in the way of coworkers if you understand the concept and apply it appropriately.

That's the purpose of this manual: to help you use appropriate fall protection for structural steel erection work.

What is Structural Steel Erection Work?

UOSHA defines steel erection as the movement and erection of skeletal steel members (structural steel) in or on buildings and nonbuilding structures.

This definition includes activities such as initial connecting, moving point-to-point, installing metal floor or roof decking, welding, and bolting. It does not include erecting nonskeletal steel such as lintels, stairs, railings, curtain walls, windows, architectural metal work, column covers, and catwalks. Nor does it include placing reinforcing rods in concrete structures.

Fall Protection Requirements for Structural Steel Erection

The fall protection requirements for structural steel work are summarized below:

Workers should be protected from fall hazards when they are on unguarded surfaces more than 6 feet above a lower level or at any height above dangerous equipment.

Workers connecting steel beams on a skeleton steel building or structure must be protected by a personal fall arrest system connected to a securely anchored lanyard or lifeline when the fall distance is greater than 25 feet. (Each anchor must be able to support at least 5,000 pounds per attached worker.) If personal fall arrest systems are not practical, safety nets can be used. However, they must be installed no more than 30 feet below the working surface.

Fall Protection and Structural Steel Erection

When is a Connecting Task Not a Connecting Task?

Structural steel connecting work involves two different types of tasks: connecting and non connecting.

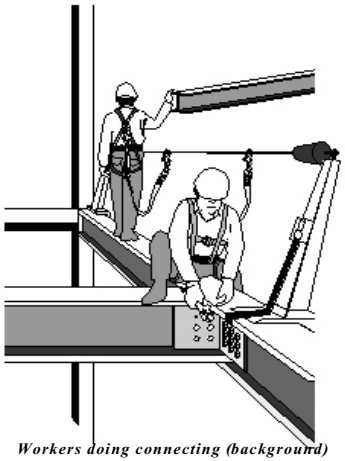
Workers do connecting tasks when they receive rigged suspended steel from a crane. They do nonconnecting tasks when the steel members no longer need to be suspended by crane and rigging.

Examples of nonconnecting tasks include:

Bolting crew tasks, such as plumbing-up guys and turnbuckles; installing, adjusting, and tightening process points; pneumatic operations at process points and moving point-to-point.

Decking layout, spot/puddle welding, and cutting tasks, moving point-to-point, and positioning.

Bridging crew tasks such as staging, placement, welding, and moving point-to-point.



Workers doing connecting (background) and nonconnecting tasks (foreground).

However, workers frequently do both connecting and nonconnecting tasks on the same job. Since connecting and nonconnecting tasks have different fall protection requirements, it's important that workers know the requirements for both types of tasks before a project begins.

A connector receiving suspended steel from a crane is allowed to work without fall protection up to 25 feet above the next lower level. After the suspended member is positioned on the top cord of the beam, the connecting phase is finished.

Example: Suppose a worker 20 feet above a lower level receives and connects bar joist suspended by a crane (connecting tasks). After finishing, the worker begins welding (a nonconnecting task), also 20 feet above a lower level. For the connecting tasks, the worker does not require personal fall protection. For the welding task, the worker should have fall protection because the work is more than 6 feet above a lower level.

Fall Protection for Connecting Work

Connectors working more than 25 feet above a lower level must be protected from falling at their work stations and while moving point-to-point. If personal fall arrest systems are not practical, safety nets can be used as long as the nets are no more than 30 feet below the working surface and meet the requirements in Subpart M, Section 1926.502(c).

A personal fall arrest system consists of a full body harness, connectors, and an anchorage. The system is connected to a lanyard, vertical lifeline, or horizontal lifeline. If a vertical lifeline or lanyard is anchored by an I-beam section, then tie-off adaptors or beam connectors must be used. For more information on vertical and horizontal lifelines, see the sections on lifelines later in this manual.

Fall Protection for Nonconnecting Work

Workers doing nonconnecting tasks can use the same fall protection systems as connectors. The only difference is that the workers doing nonconnecting tasks should use fall protection when they are more than 6 feet above a lower level. Here are some fall protection suggestions for doing typical nonconnecting tasks:

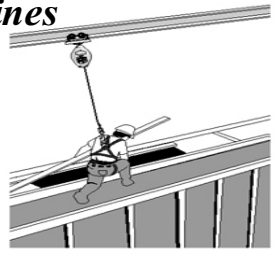
Use a personal fall arrest system while doing open sided/leading edge decking work 6 or more feet above a lower level.

Use retractable lanyards secured to structural members while doing leading edge work involving positioning, layout, cutting, or spot welding.

Pre-install engineered horizontal lifeline systems to protect workers who will do positioning, layout, and spot-welding tasks.

Use a double lanyard for moving point-to-point.

Lifelines

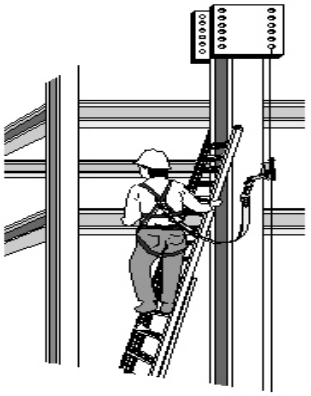


Vertical Lifeline (self-retracting)

Horizontal Lifeline

A lifeline is a flexible cable or rope that attaches to a worker's body belt, harness, lanyard, or deceleration device and to an anchor. A lifeline that hangs vertically from an anchor is a vertical lifeline. A lifeline that stretches horizontally between two anchors is a horizontal lifeline. Lifelines must be protected from cuts and abrasions. They cannot be made with natural fiber rope.

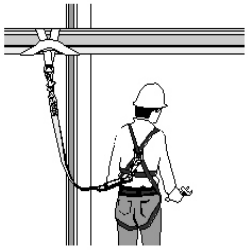
Installing and Using Vertical Lifelines on Columns and Beams



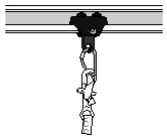
Only one worker can be attached to a vertical lifeline. The lifeline must have a minimum breaking strength of 5,000 pounds and must be connected directly to the worker's full body harness, lanyard, or deceleration device.
Here are two common methods for anchoring vertical lifeline to a column. You can attach the lifeline to the top of the column while the column is still on the ground. Or, if the column is already in place and the configuration of the structure permits it, you may be able to use a ladder or a powered elevated work platform to attach the lifeline to the top of the column.

There are many ways to anchor vertical lifelines to beams. If you don't need to move from your work area, you can attach a shock-absorbing lanyard to an overhead beam with a tie-off adaptor. If you need to move about, you can use a self-retracting lifeline or a beam trolley. A variety of self-retracting lifelines and connecting clamps are available from fall protection equipment suppliers.

Consider the potential for a "swing fall" whenever you use a self-retracting lifeline. You increase the risk of a "swing fall" by moving away from the anchorage point and increasing the lifeline length. You will swing back under the anchorage during a fall. A "swing fall" increases your risk of striking an object or lower level during the pendulum motion.



Worker using a tie-off adaptor and shock- absorbing lanyard.

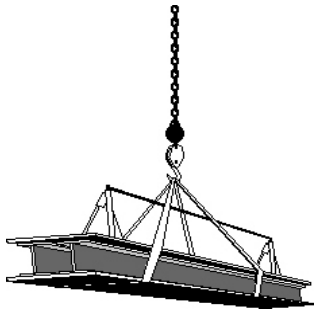


"Beam Trolley"

Installing and Using Horizontal Lifelines

Horizontal lifelines lines should be designed and installed before steel beams are erected. Some commercially available systems use I-beam flange clamps to hold a pair of columns supporting a horizontal line. The worker can connect to the lifeline with a shock-absorbing lanyard or a self-retracting lifeline.

Horizontal lifelines can also be installed after beams are erected; however, there should be attachment points on the structural members, such as welded lugs or punched holes, that permit a secure anchor to be installed. Workers making the initial horizontal lifeline connections and installing the lines also need to be protected from falls.



Horizontal lifelines should be installed before steel beams are erected.

Here are two ways to protect them: (1) use a powered elevating work platform, or (2) when a column is erected, anchor a vertical lifeline on top of the column and extend the lifeline to the access level. A worker can connect to the vertical lifeline with a rope grab and a personal fall arrest system.

Horizontal lifelines, depending on their geometry and angle of sag, can be subjected to greater loads than the impact load imposed by an attached component. When the horizontal lifeline sag angle is less than 30 degrees, the impact force generated by an attached lanyard is greatly amplified. For example, with a sag angle of 15 degrees, the force is about 2:1, and at 5 degrees sag, it is about 6:1. Depending on the angle of the sag and the line's elasticity, the strength of the horizontal lifeline and the anchorages to which it is attached should be increased several times over that of the connecting components. To minimize potential loads on a horizontal lifeline, increase the sag angle or to use a shock-absorbing lanyard or self-retracting lifeline with a personal fall arrest system.

Horizontal lifeline anchorages must be capable of supporting at least 5,000 pounds per attached worker; otherwise, they must be designed and installed with a safety factor of at least two (twice the impact force of a potential fall), under the supervision of a qualified person. OSHA defines a qualified person as one who, "by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated the ability to resolve problems relating to a specific subject, operation, or project."

Whenever you use a horizontal lifeline, a qualified person must be available to make sure the system is properly installed, supervised, and inspected. A horizontal lifeline used by more than one worker at a time should be planned and set up with extreme care.

Temporary floors

As the steel frame of the building is going up, tightly planked floors must be installed every two stories or 30 feet, whichever is less. Floors must be constructed directly below the tier of beams on which work is being done unless workers are gathering temporary floor planks from a lower level to transfer them to an upper level.

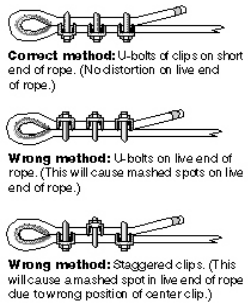
Frame exposure

There cannot be more than four floors or 48 feet of unfinished bolting or welding above the foundation or uppermost permanently secured floor.

Periphery Safety Railing

A safety railing, 42 inches high (+ 3 inches), must be installed around the periphery of all temporary planked or temporary metal-decked floors during structural steel assembly. The railing line must be made of 1/2 inch wire rope or material of equal strength, flagged every six feet with highly visible material.

The railing may be constructed with pre-installed /welded, 1/4-inch-thick washers connected to each vertical perimeter structural steel member. The 1/2 inch wire rope is threaded through each of the washer eyes to form a single cable railing. The ends of the wire rope are secured to the columns with three U-bolt wire rope clips on each dead end of the rope. Wire rope clips and other end connections, if not properly installed and tightened, can fail at the connection points. Wire rope clips must never have the saddle on the 'dead' side of the line.
(Remember the saying, "You never saddle a dead horse.")



Using wire rope U-bolt clips.

The wire clips must be drop forged and installed with a three-inch spacing between them (six times the rope diameter) The clips must be torqued to proper tightness. After the railing is secured, the wire rope line cannot sag below 39 inches when a 200-pound load is applied to it in a downward direction.

Training

Employers and workers must be aware of workplace fall hazards and they must take appropriate action to eliminate or minimize those hazards. They should select the appropriate fall protection for a particular task or process and train workers to use it appropriately. Employers should provide training for all workers exposed to fall hazards so that they can:

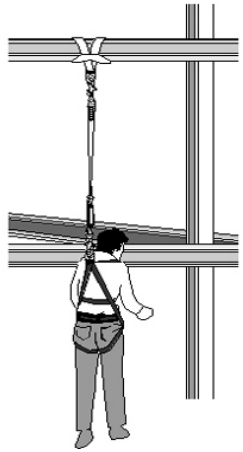
Recognize fall hazards in their work area.

Use appropriate procedures to minimize exposure to fall hazards.

Workers who use or intend to use a personal fall arrest system should also know:

-How to inspect the equipment before they use it.
-How to wear the equipment.
-Proper hook-up and attachment methods.
-Appropriate anchoring and tie-off techniques.
-How to estimate free fall distances.
-Equipment care and storage procedures.
-Rescue procedures and techniques.

Emergencies



Fall protection systems are designed to minimize workers' exposure to fall hazards and to reduce their risk of injury if they do fall. However, employers are responsible for establishing procedures to ensure that workers who fall receive prompt emergency and medical attention. Emergency procedures should identify key rescue and medical personnel, equipment available for rescue, emergency communications procedures, retrieval methods, and primary first aid requirements. Employers should also establish fall arrest rescue procedures before workers use personal fall arrest systems.

Note: Workers in 9-1-1 service areas can use the number for ambulance service; however, most 9-1-1 responders are not trained to rescue an injured worker suspended in a personal arrest system. Rescue procedures must ensure prompt response to a suspended worker. The 9-1-1 number does not ensure prompt rescue.

Use the guidelines below to develop your own emergency response procedures.

Before Onsite Work Begins

Make fire department or emergency response units aware of the job specifications at the site and any factors that may slow response time.

Document the rescue plan and make sure it is posted at the worksite.
Post emergency responder phone numbers and addresses at the worksite.
Mark the job site with signs and note the easiest access routes in and out of the site.
Make sure you have quick access to rescue and retrieval equipment such as lifts and ladders.

As Onsite Work Progresses

Identify onsite equipment that can be used for rescue and retrieval. Examples: lifts and ladders.
Maintain a current equipment inventory at the site. Equipment may change frequently as the job progresses.
Reevaluate and update the emergency response plan if onsite work tasks change.

Responding to Emergencies

If the worker is injured, call 9-1-1 or other emergency numbers indicated on the emergency response plan for ambulance service. Remember, 9-1-1 responders cannot accomplish prompt rescues. First responders should clear a path to the victim. Others should be sent to direct emergency personnel to the scene.

Make sure only qualified personnel attempt a technical rescue.
Prohibit all nonessential personnel from the fall/rescue site.
Talk to the fall victim. Determine the victim's condition, if possible.

If the victim is accessible, provide comfort and check vital signs. If necessary, administer CPR and attempt to stop bleeding.

Investigating Accidents

Report fatalities and catastrophes to UOSHA within twelve hours.
Identify all equipment associated with the accident and place it out of service until the accident investigation is complete.

Document, step-by-step, what went wrong and what went right.

Review your fall protection plan. Determine how the plan could be changed to prevent similar accidents. Revise the plan accordingly.

Have a competent person examine equipment associated with the accident. If it contributed to the accident, determine how and why. Replace it if necessary.

(Note: OSHA defines a competent person as one "who is capable of identifying existing and predictable hazards in the work environment and who has authorization to take prompt measures to eliminate the hazards.")

Definitions of Selected Terms

Anchorage:

A secure point of attachment for workers' lifelines, lanyards, or deceleration devices. Anchorages must be capable of supporting a minimum load of 5,000 pounds per worker (or be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall arrest system which maintains a safety factor of at least two).

Body harness:

Straps that an individual wears to distribute fall arresting forces over the thighs, waist, chest, shoulders, and pelvis. Attaches to other components of a personal fall arrest system. The maximum arresting force permitted for a body harness is 1,800 pounds.

Competent person:

One who is capable of identifying existing and predictable hazards in the work environment and who ***has authorization to take prompt measures to eliminate the hazards.***

Connector:

(1) A device used to couple (connect) components of a personal fall protection system or positioning device system. The connector may be an independent component (such as a carabinier) or an integral component (such as a buckle or D-ring sewn into a body belt) of the system. Connectors must be drop forged or made of equivalent materials; they must have a corrosion-resistant finish, and all surfaces and edges must be smooth to prevent damage to other parts of the system.

Non-locking connectors are prohibited after January 1, 1998. (2) A trained iron worker who makes the initial connection of structural steel members.

Deceleration device:

Any mechanism that dissipates or limits energy imposed on a person during fall arrest. Examples include rope grabs, rip stitch lanyards, special woven lanyards, and automatic self-retractinglifelines.

Lanyard:

A flexible rope, strap or webbing that connects a body belt or harness to a deceleration device, lifeline, or anchor. Lanyards that tie-off one worker must have a minimum breaking strength of 5,000 pounds. Lanyards that automatically limit free-fall distance to two feet or less must have components capable of sustaining a minimum static tensile load of 3,000 pounds with the lanyard in the fully-extended position.

Lifeline:

A flexible line that attaches directly to a person's body belt, harness, lanyard, or deceleration device at one end and to an anchor at the other end. A lifeline that hangs vertically and is connected to one anchor is a vertical lifeline. A lifeline that stretches horizontally between two anchors is a horizontal lifeline. All lifelines must be protected against cuts or abrasions; they cannot be made of natural fiber rope.

Non-building Structures:

Bridges, viaducts, overpasses, towers, tanks, billboards, antennas, and other similar structures.

Personal fall arrest system:

A conventional fall protection system designed to stop a single worker from free falling to a lower level. Components include an anchorage, connectors, a body belt or body harness, and may include a lanyard, deceleration device or lifeline. After January 1, 1998, body belts and non-locking connectors are prohibited.

Safety net system:

A fall arrest system of mesh nets including panels, connectors, and other impact-absorbing components.

Steel erection:

The movement and erection of skeleton steel members (structural steel) in or on buildings and non-building structures.

Tiered:

Implies that a skeleton steel framework is erected in vertically stacked columns; it is not limited to multi-floor structures.

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